CLAIMS:

1. A method of modifying the activity of the heart, or of a portion thereof, comprising applying to said heart, or portion thereof a non-excitatory electric field of a magnitude, shape, duty cycle, phase, frequency and duration suitable to obtain the desired change, wherein said field is applied at a time such as to be unable to generate a propagating action potential.

2. A method according to claim 1, wherein the portion of the heart to which the non-excitatory field is applied is a heart chamber.

3. A method according to claim 1, wherein the non-excitatory electric field comprises an alternated current electric field.

4. A method according to claim 1, wherein the non-excitatory electric field has a temporal envelope selected from exponential temporal envelope, sinusoidal temporal envelope, square temporal envelope, triangular temporal envelope, ramped temporal envelope, sawtooth temporal envelope and biphasic temporal envelope.

5. A method according to claim 1, wherein the desired change is an increase of the force of contraction of said heart, heart chamber or portion thereof.

6. A method according to claim 1, wherein the desired change is an increase of the stroke volume of a chamber of the heart.

7. A method according to claim 1, wherein the desired change is an increase of the output flow of a chamber of the heart.

8. A method according to claim 1, wherein the desired change is a change in pressure.

9. A method according to claim 8, wherein the pressure is end diastolic pressure or end systolic pressure of a chamber or aortic pressure.

10. A method according to claim 1, wherein the desired change is a change of the heart rate.

11. A method according to any one of claims 1 to 10, comprising sensing the activation of a portion of the heart at a suitable location, and thereafter calculating or estimating therefrom the activation time of the portion of the heart the activity of which it is desired to modify.

12. A method according to claim 11, further comprising determining the delay at which the non-excitatory electric field is to be applied from said activation time.

13. A method according to any one of claims 1 to 12, wherein the portion of the heart the activity of which it is desired to modify comprises a plurality of sub-portions having each independently defined activations, and wherein separate non-excitatory electric fields are applied to a plurality of said sub-portions, independently or in synchronization with one another.

14. A method according to any one of claims 1 to 13, wherein the activation of the heart, the heart chamber, or of portions thereof, is obtained by pacing, and wherein the application of the non-excitatory electric field is synchronized with the pacing signal and is effected with a timing relative to the pacing signal.

15. A method according to any one of claims 1 to 13, wherein a defibrillating signal is provided to the heart, and wherein the application of the non-excitatory electric field is synchronized with said defibrillating signal.

16. A method of performing cardiac surgery comprising applying to the heart, or to a portion thereof a non-excitatory electric field of a magnitude, shape, duty cycle, phase, frequency and duration suitable to control the electro-mechanical activity of the tissue in the area on

which surgery is to be performed, wherein said field is such as to inhibit a propagating action potential, and thereafter performing the required surgical procedure on said area.

17. A method of performing cardio-vascular surgery comprising applying to the heart chamber or to a portion thereof a non-excitatory electric field of a magnitude, shape, duty cycle, phase, frequency and duration suitable to reduce the output flow, contractility, or pressure thereof, when surgery is performed on tissue perfused by the flow of said chamber, wherein said field is such as to be unable to generate a propagating action potential, and thereafter performing the required surgical procedure on said area.

18. A method of reducing an output of a chamber of a heart, comprising applying to a portion of said heart chamber a non-excitatory electric field of a magnitude, shape, duty cycle, phase, frequency and duration suitable to obtain the desired change, wherein said field is applied at a time such as to be unable to generate a propagating action potential, and wherein reducing the output of the chamber is obtained by reducing the reactivity of said portion, or its sensitivity, to an activation signal, or by reversibly blocking its conduction pathway.

19. A method of treating an abnormal activation of the heart, particularly fibrillation, comprising applying to said heart or to a portion thereof a non-excitatory electric field of a magnitude, shape and duration suitable to treat the abnormal activation condition, wherein said field is such as to be unable to generate a propagating action potential.

20. A method according to claim 1, wherein the electric field is applied at one or more of the positions selected from among the group consisting essentially of internally or externally to the heart, within a blood vessel, intramuscularly, along the normal conduction direction or perpendicularly thereto.

21. A method according to claim 1 wherein the electric field is applied using electrodes selected from unipolar electrodes or bipolar electrodes.

22. A method according to claim 11, wherein the activation is sensed by sensing a value of a parameter of an ECG, and wherein the activation time is estimated based on a delay value associated with the value of the parameter.

23. A method according to, claim 1 wherein the application of the non-excitatory field is repeated during a plurality of heart beats, and wherein said repeated application is effected by skipping the application of the field to some of the beats in a train of consecutive heart beats, and/or by reducing the frequency at which the beats are skipped is gradually reduced, and/or by changing between beats the size of the portion of the heart to which the field is applied.

24. A method of modifying the electro-mechanical activation of at least a portion of a heart, comprising mapping the activation profile of the portion, determining the desired change in the activation, and modifying the conduction velocity in a non-arrhythmic segment of the portion, wherein the non-excitatory electric field is of a magnitude, shape, duty cycle, phase, frequency and duration suitable to obtain the desired change.

25. A method of modifying the activation profile of at least a portion of a heart, comprising mapping the activation profile of said portion, determining the desired change in the activation profile and changing the refractory period of at least a segment of the portion, wherein the non-excitatory electric field is of a magnitude, shape, duty cycle, phase, frequency and duration suitable to obtain the desired change, and wherein said segment is selected from a segment that is not part of a reentry circuit or an arrhythmia focus in the heart, a segment that is a part of a reentry circuit or an arrhythmia focus in the heart, or an ischemic segment.

26. A method of modifying the activation profile of at least a portion of a heart, comprising mapping the activation profile of said portion, determining the desired change in the activation profile and reversibly blocking the activation of at least a segment of the portion, wherein the non-excitatory electric field is of a magnitude, shape, duty cycle, phase, frequency and duration suitable to obtain the desired change, and wherein said

segment is selected from a segment that is not part of a reentry circuit or an arrhythmia focus in the heart, a segment that is a part of a reentry circuit or an arrhythmia focus in the heart, or an ischemic segment.

27. A method of treating a segment of the heart which induces arrhythmias due to an abnormally low excitation threshold, comprising identifying the segment and applying thereto a desensitizing electric field such that said excitation threshold is increased to a normal range of values.

28. A method according to claim 1, wherein the change comprises selectively and reversibly increasing or reducing the contractility of one of the portions or ventricles of the heart relative to another portion or to the other ventricle.

29. A method according to claim 1, further comprising determining a desired range of values for at least one parameter of cardiac ~~activity and~~ controlling at least a local force of contraction of the heart to maintain said parameter within the desired range.

30. Heart control apparatus, comprising circuitry for generating a non-excitatory electric field, and electrodes for applying to a heart or to a portion thereof said non-excitatory electric field, wherein said circuitry for generating a non-excitatory electric field generate a field with a timing relative to the activation of the heart or of a portion thereof, and of a magnitude, shape, duty cycle, phase, frequency, and duration such as to be unable to generate a propagating action potential.

31. Apparatus according to claim 30, comprising means for generating an AC non-excitatory electric field.

32. Apparatus according to claim 30, comprising means for imparting to the non-excitatory electric field a temporal envelope selected from exponential temporal envelope, sinusoidal temporal envelope, square temporal envelope, triangular temporal envelope, ramped temporal envelope, sawtooth temporal envelope, and biphasic temporal envelope.

33. Apparatus according to claim 30, further comprising means for mapping the activation profile of the portion.

34. Heart control apparatus according to claim 30, wherein the electrodes are suitable to be positioned externally to the body.

35. Heart control apparatus according to claim 30, said apparatus being suitable for controlling a parameter selected from the force of contraction, heart rate, stroke volume, chamber or aortic pressure, or output flow.

36. Heart control apparatus according to claim 30, wherein the electrodes comprise at least one unipolar electrode and a housing which functions as a second electrode.

37. Apparatus according to claim 30, comprising at least two electrodes, suitable to apply said non-excitatory electric field across at least one predetermined portion of the heart.

38. Apparatus according to claim 30, comprising at least three electrodes, wherein each pair of said at least three electrodes is selectively and separately electrifiable.

39. Apparatus according to claim 30, comprising a sensor adapted to sense the activation of a portion of a heart, and field application circuitry adapted to apply said field to the electrodes as a response to activation sensed by said sensor.

40. Apparatus according to claim 39, further comprising logic circuitry to calculate the application parameters of the electric field from the activation sensed by the sensor.

41. Apparatus according to claim 40, wherein the application parameters include the delay time from the sensed activation.

42. Apparatus according to claim 39, further comprising multiple sensors that sense independently or in a combined logic.

43. Apparatus according to any one of claims 30 to 42, further comprising feedback control means to measure at least one physiological response to the electrification of the electrodes, and to modify the application parameters of the non-excitatory electric field as a result of said responses in order to maintain said responses within a predetermined range of values.

44. Apparatus according to any one of claims 30 to 43, further comprising synchronization circuitry, to synchronize the application of the non-excitatory electric field to the pacing signal generated by a pacemaker wherein the pacemaker and the remainder of the apparatus are contained in a common housing and use common electrodes.

45. Apparatus according to any one of claims 30 to 43, further comprising synchronization circuitry, to synchronize the application of the non-excitatory electric field to the defibrillating signal generated by a defibrillator wherein the defibrillator and the remainder of the apparatus are contained in a common housing and use common electrodes.

46. Cardiac surgery aiding apparatus, comprising circuitry for generating a non-excitatory electric field, and electrodes for applying to a heart or to a portion thereof said non-excitatory electric field, wherein said circuitry for generating a non-excitatory electric field generate a field of a magnitude, shape duty cycle, phase, frequency and duration suitable to control the electro-mechanical activity of the tissue in the area on which surgery is to be performed, and wherein said field is unable to generate a propagating action potential.

47. Cardio-vascular surgery aiding apparatus, comprising circuitry for generating a non-excitatory electric field, and electrodes for applying to a heart chamber or to a portion thereof said non-excitatory electric field, wherein said circuitry for generating a non-

excitatory electric field generate a field of a magnitude, shape, duty cycle, phase, frequency and duration suitable to reduce the output flow, contractility, or pressure of said chamber, when surgery is performed on tissue perfused by the flow of said chamber, and wherein said field is such as to be unable to generate a propagating action potential, and thereafter performing the required surgical procedure on said area.

48. Apparatus according to claim 33, further comprising circuitry for modifying the conduction velocity in a non-arrhythmic segment of a heart portion.

49. Apparatus according to claim 30, comprising circuitry for sensing the activation by sensing a value of a parameter of an ECG, and circuitry for estimating the activation time based on a delay value associated with the value of the parameter.

50. Apparatus according to claim 30, comprising means for electrifying the electrodes using a single signal which combines a pacing signal and a non-excitatory electric field.

51. Apparatus according to claim 30, comprising controlling means and memory means to coordinate the electrification of all the electrodes.

52. A method of modifying the activity of a heart or portion thereof, comprising providing one implantable light source which generates pulses of light, for at least 1000 cardiac cycles, over a period of less than 5000 cycles or a plurality of light sources each attached to a different site of the heart, and a wave guide for providing non-damaging intensities of light from the light source to at least one site of the heart.

53. A method of modifying the activity of the heart or a portion thereof, comprising irradiating the portion with radio frequency radiation synchronized to the activation of said heart or portion thereof, and repeating said irradiation at at least 100 cardiac cycles, during a period of less than 1000 cardiac cycles.

54. A method of controlling a heart, comprising applying a non-excitatory electric field to a first portion of a chamber of said heart, such that a force of contraction of the first portion is lessened, and applying a non-excitatory electric field to a second portion of a chamber, such that a force of contraction of the second portion is increased.

55. Apparatus for modifying the activity of a heart or portion thereof, comprising one implantable light source which generates pulses of light, for at least 1000 cardiac cycles, over a period of less than 5000 cycles or a plurality of light sources each attached to a different site of the heart, and a wave guide for providing non-damaging intensities of light from the light source to at least one site of the heart.

56. Apparatus for modifying the activity of the heart or a portion thereof, comprising means for irradiating the portion with radio frequency radiation synched to the activation, and means for repeating irradiating at at least 100 cardiac cycles, during a period of less than 1000 cardiac cycles.

57. Heart control apparatus comprising circuitry for applying a non-excitatory electric field to a first portion of a heart chamber, such that a force of contraction of the first portion is lessened, and circuitry for applying a non-excitatory electric field to a second portion of a chamber, such that a force of contraction of the second portion is increased.

58. Apparatus according to claim 30, comprising circuitry for applying separate non-excitatory electric fields, independently or in synchronization with one another, to a plurality of sub-portions of a heart, having each independently defined activations.

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